



Impact of New Terrain Data GMTED2010 on FV3GFS Forecast

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Environmental Modeling Center
National Centers for Environmental Prediction

GTOPO30 Data

- FV3GFS currently uses GTOPO30 terrain data.
 - Mapped to the cubed-sphere grid using Jordan's orography program.
 - https://svnemc.ncep.noaa.gov/fv3gfs/trunk/global_shared.v15.0.0/ sorc/orog.fd
 - Separate data used for Antarctica more on this later.
 - Radarsat Antarctic Mapping Project (RAMP) Digital Elevation Model Liu, H. et al. (2001). A 1-km dataset.
 - GTOPO30 had several deficiencies (did not resolve large ice sheets).
- Global 30 arc-seconds (about 1 km).
 - But not really 30-sec everywhere.
- Created by USGS in 1996 from eight different sources.
 - No single, global source at the time.
- Quality varies from continent to continent (and even within continents).

GMTED2010 Data

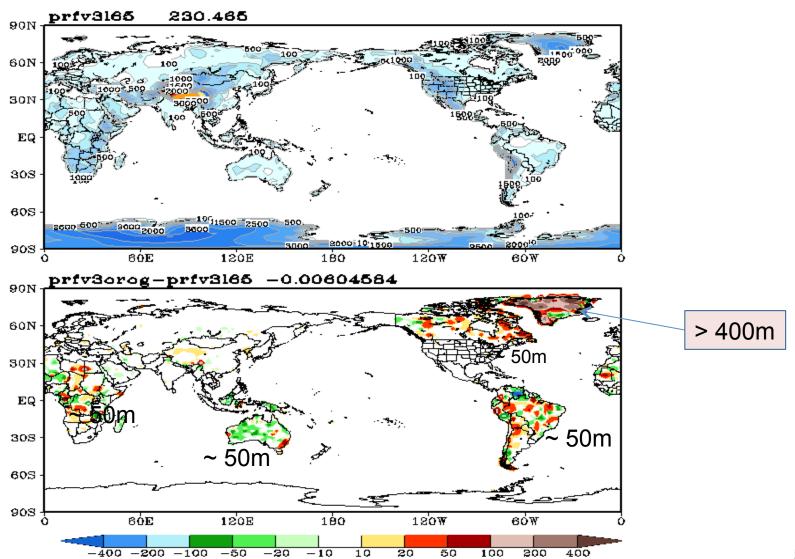
- More accurate replacement for GTOPO30 data.
 - Created by USGS in 2010.
 - Primarily derived from NASA Shuttle Radar Topography Mission (SRTM) data.
- Three different resolutions 30/15/7.5 arc second.
 - Corresponds to 1000/500/250 meters.
 - 30 arc-second data is global.
 - 15 and 7.5 arc-second versions have no data for Antarctica or Greenland.
 - I have only acquired the 30 and 15-second versions.
- For more details, see: https://lta.cr.usgs.gov/ GMTED2010

NEMS FV3GFS Forecasts

- Model: NEMS FV3GFS + CAP + IPDv3 +NSST, non-hydrostatic, non-mono, 32-bit
- Physics: Q3FY17 NEMS GSM physics, including NSST model, updated convection, new high-resolution MODIS land datasets and a few other minor updates.
- Initial Conditions: NEMS GSM (global spectral model) ICs, converted to FV3 grid using CHGRES
- Forecast Length: 240 hours, 3-hourly output
- **Control**: FV3GFS C768 (~13km) L64 (top at ~0.4 hPa), prfv3l65
- **Experiment JJA 2016 (prfv3orog)**: 01Jun2016 ~ 30Aug2016
 - http://www.emc.ncep.noaa.gov/gmb/wx24fy/NGGPS/fv3orog_jja/
- Experiment JFM 2017 (prfv3orog): 03Jan2017 ~ 31Mar2017
 - http://www.emc.ncep.noaa.gov/gmb/wx24fy/NGGPS/fv3orog_djf/

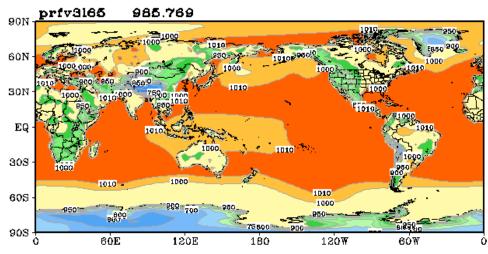
Surface Height

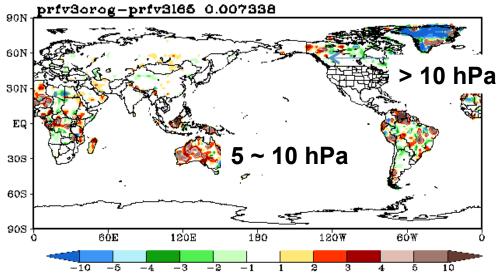
Surface Geopotential Height [gpm] 00Z-Cyc 15Jan2017-15Jan2017 Mean (f120 f120 f120 f120) Fost-Hour Average



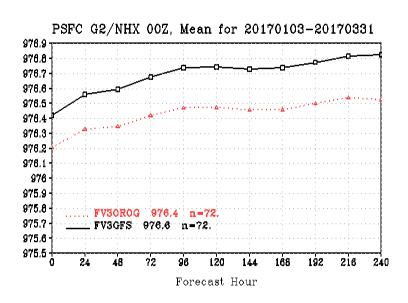
Surface Pressure

Surface Pressure [hPa] 00Z-Cyc 09Jan2017-02Feb2017 Mean (f06 f12 f18 f24) Fost-Hour Average





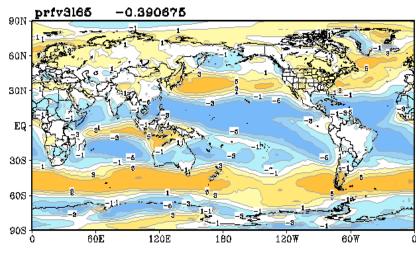
NH Psfc Mean

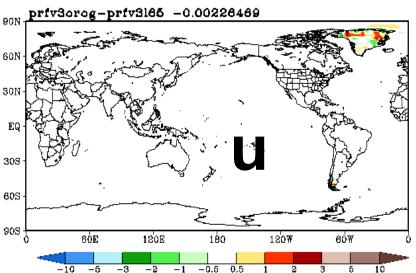


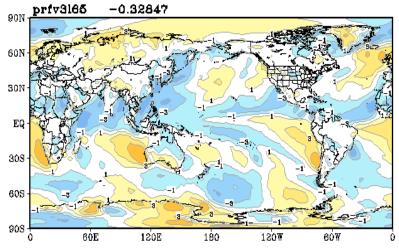
Surface 10-m Wind (1-dy fcst)

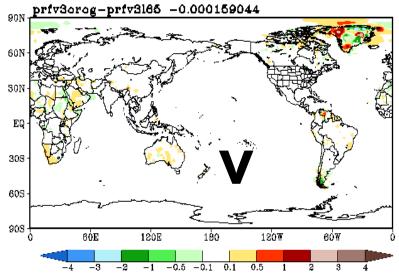
10m Above Ground Zonal Wind [m/s] 00Z-Cyc 09Jan2017-02Feb2017 Mean (f06 f12 f18 f24) Fost-Hour Average









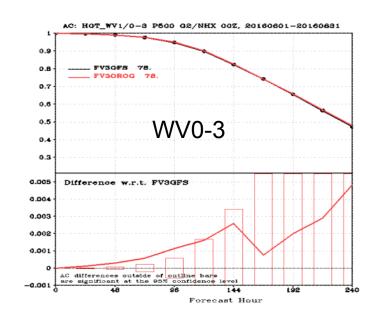


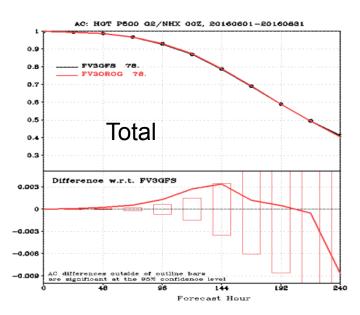
Skill Scores

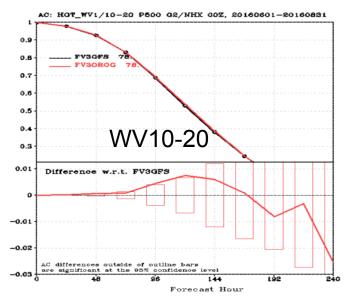
JJA 2016

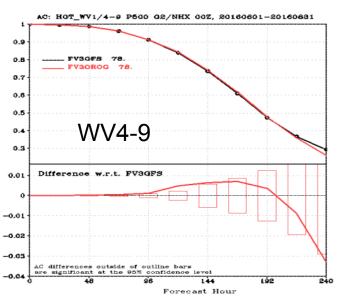
JJA 2016, NH 500-hPa HGT AC

slightly improved for all waves



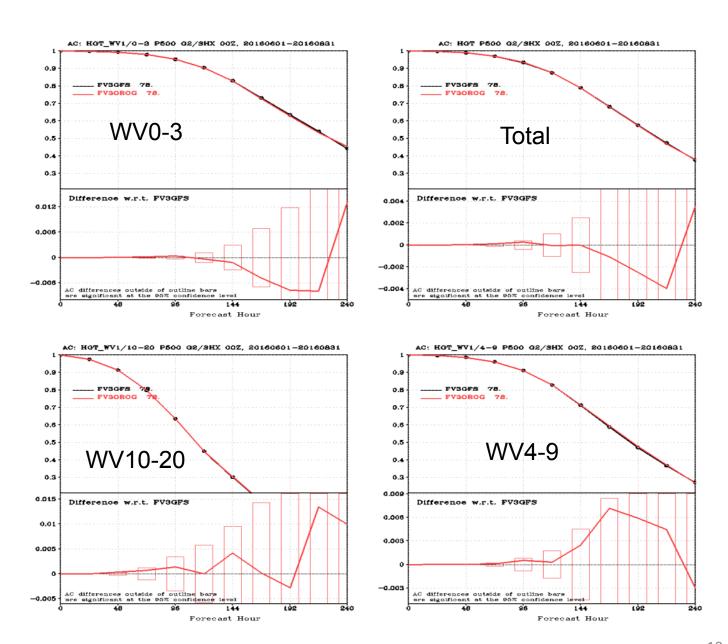




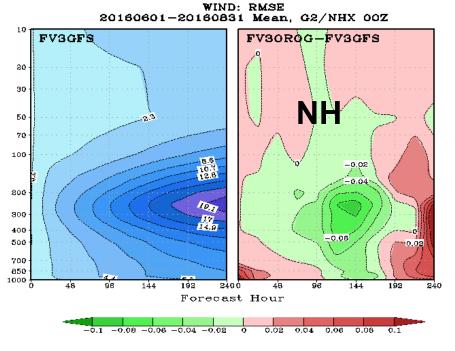


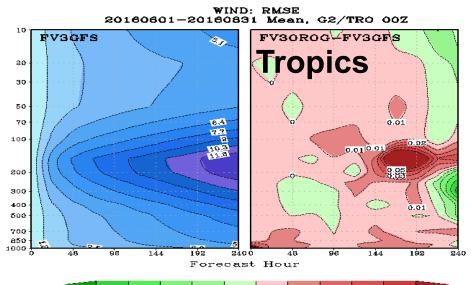
JJA2016, SH 500-hPa HGT AC

long waves slightly worse, insignificant



JJA2016, Winds RMSE



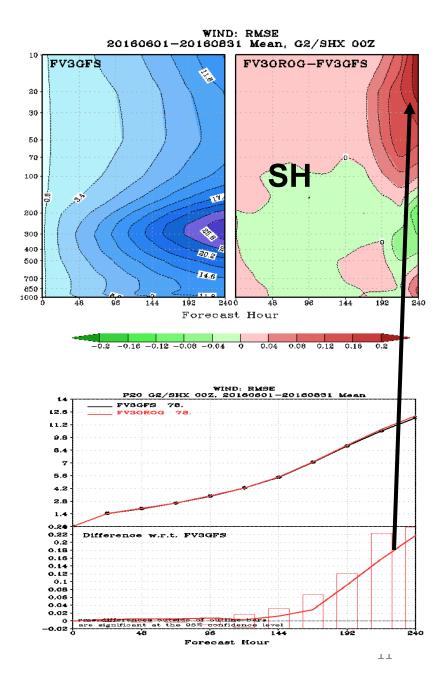


0.01

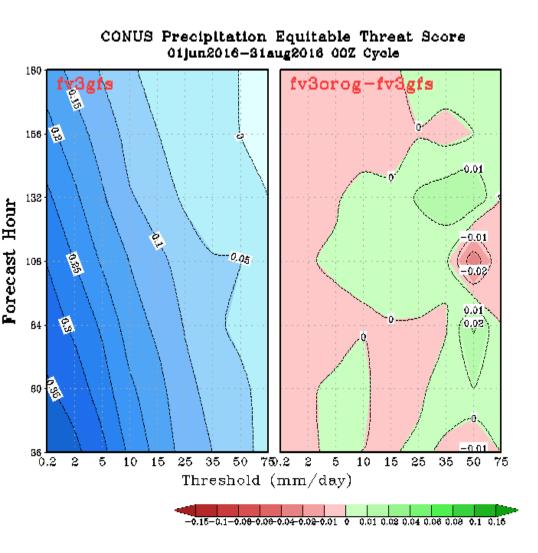
0.02

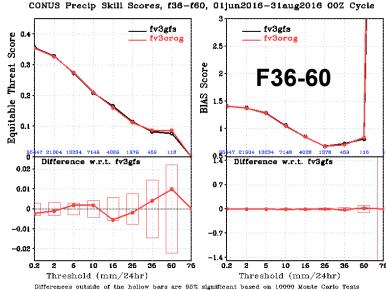
0.03

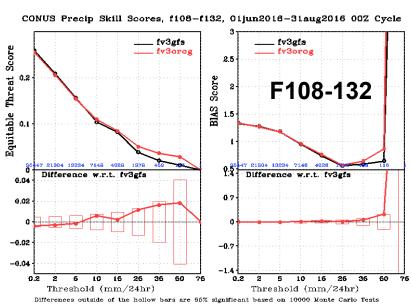
-0.05 -0.04 -0.03 -0.02 -0.01



JJA2016, CONUS Precip ETS and BIAS scores



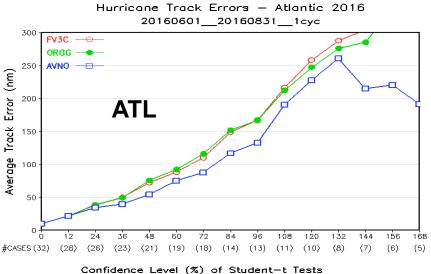




JJA2016 SCORECARD

EMC Verification Scorecard						N. An	ierica	n			N	l. Hen	nisphe	ere	v.		5	S. Hen	nisphe	ere				Tro	opics		
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FV3OROG is better than FV3GFS at the 95% significance		Heights	500hPa	A						A	A	A					A .		_								
level			700hPa	•						•	A						•										
No statistically significant difference between FV3OROG and FV3GFS			1000hPa							A	A						A .				ļ						
FV3OROG is worse than FV3GFS at the 95% significance	Anomaly	Vector	250hPa																								
level FV3OROG is worse than FV3GFS at the 99% significance	Correlation	Wind	500hPa									A															
level			850hPa	•						•									_								
FV3OROG is worse than FV3GFS at the 99.9% significance level			250hPa																_								
Not statistically relevant		Temp	500hPa																-		-						
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JJA 2016 Hurricane Track

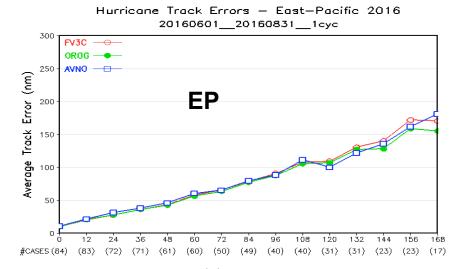


Confidence Level (%) of Student-t Tests

FV3C_OROG 0 79 64 76 96 96 95 76 51 70 89 86 90 80 8

FV3C_AVNO 56 51 81 92 98 83 91 92 87 72 68 63 85 94 9

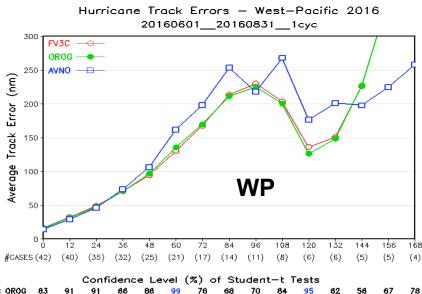
OROG_AVNO 56 54 82 91 99 91 95 93 87 68 61 57 78 87 86



OROG AVNO

64

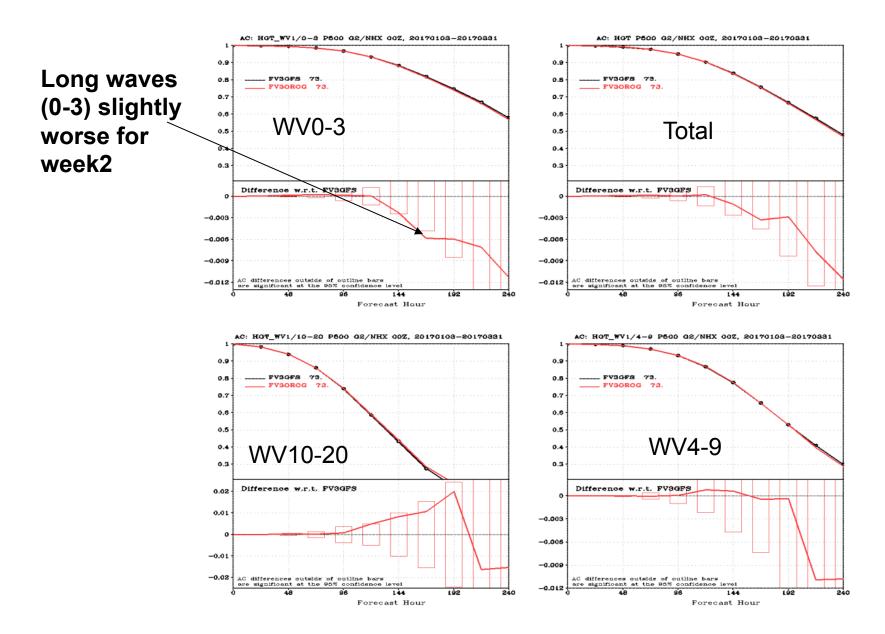
Red-cntl, Green-orog, Blue-ops GFS



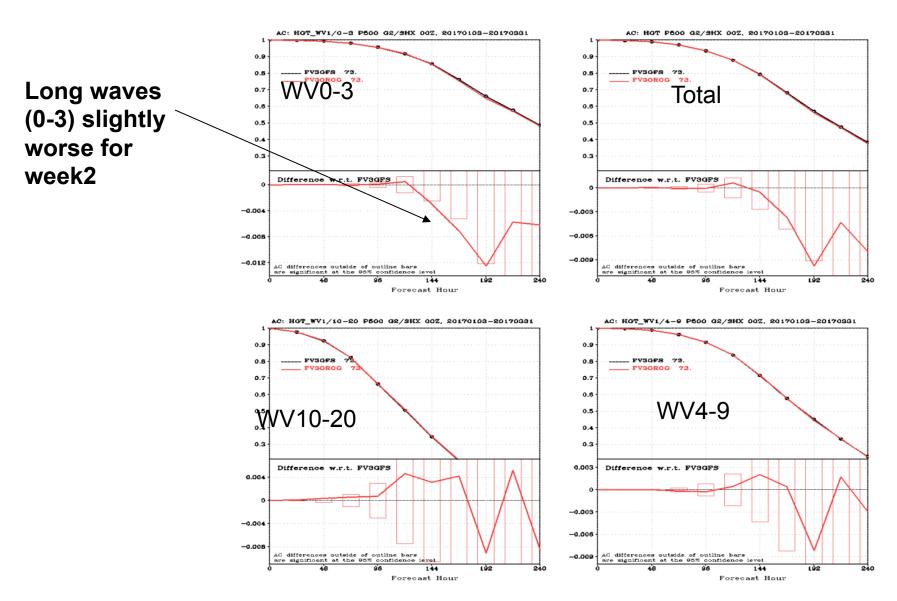
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FV3C_OROG	83	91	91	88	86	99	76	68	70	84	95	62	56	67	7
FV3C_AVNO	93	84	67	61	81	95	94	90	65	88	78	77	83	99	9
OROG_AVNO	92	78	61	60	77	92	92	92	57	89	81	78	87	99	9

Skill Scores JFM 2017

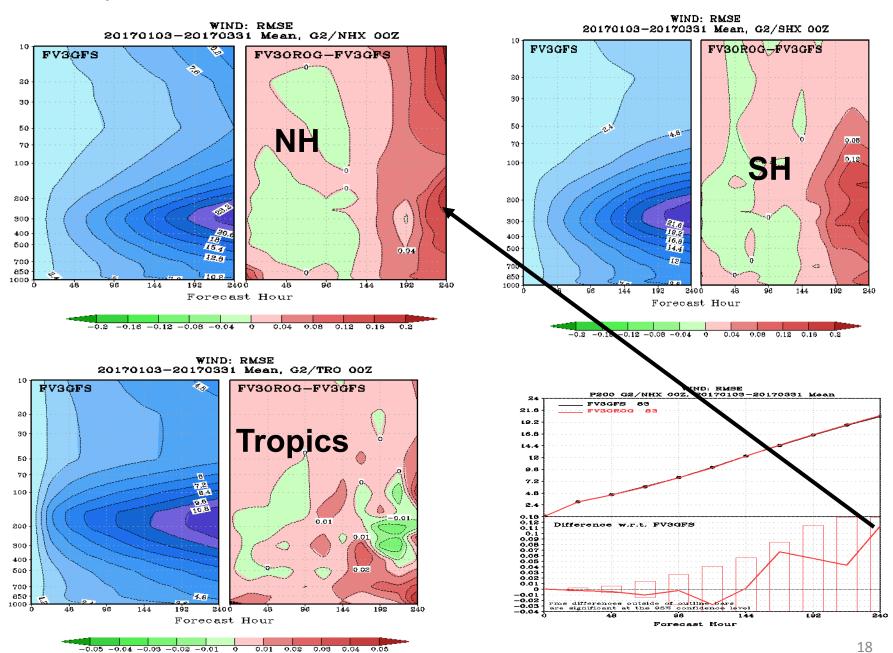
JFM2017, NH 500-hPa HGT AC



JFM2017, SH 500-hPa HGT AC



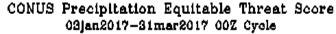
JFM2017, Winds RMSE

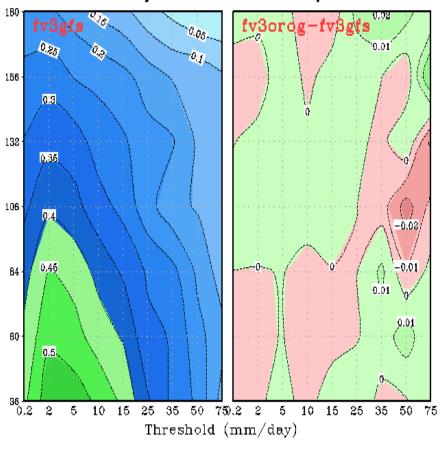


0.01

0.02 0.09 0.04

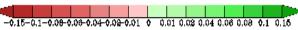
JFM2017, CONUS Precip ETS and BIAS scores

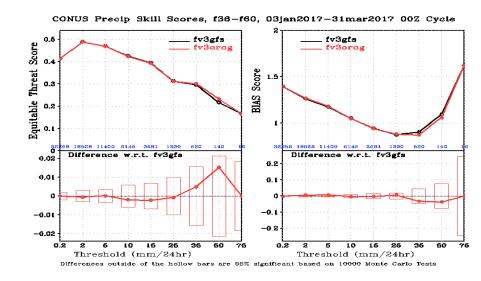


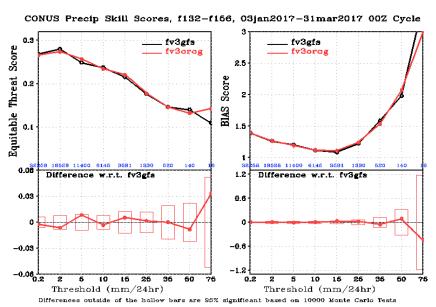


Hour

Forecast







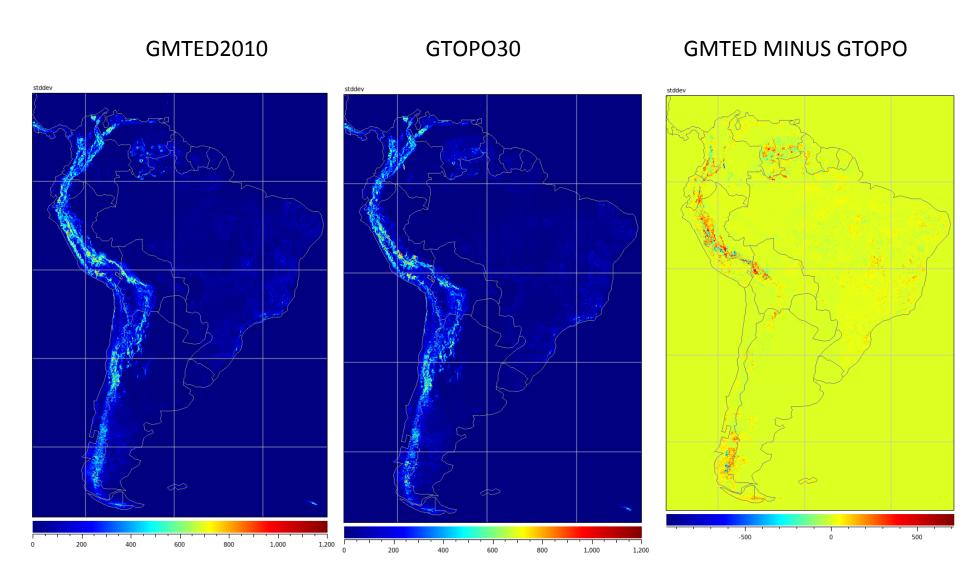
JFM2017, SCORECARD

																										Symbo	ation Scorecard of Legend
																											FS at the 99.9% significance
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EMC Verification Scorecard

Tuning

Terrain Standard Deviation



ORANGE/RED INDICATES TERRAIN MORE VARIABLE WITHIN GRID CELL.

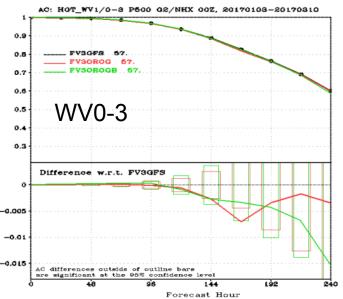
mountain block and orographic gravitywave drag vary with terrain characteristics.

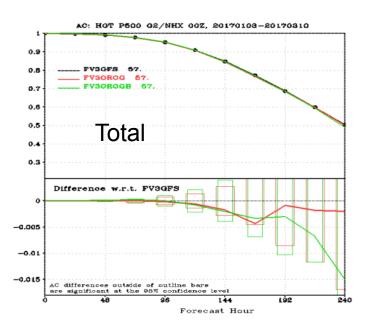
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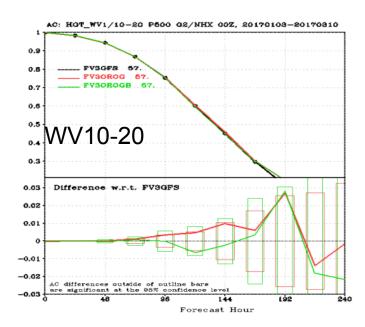
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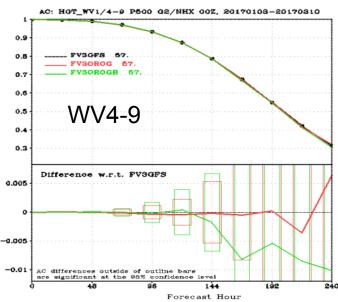
JF2017, NH 500-hPa HGT AC



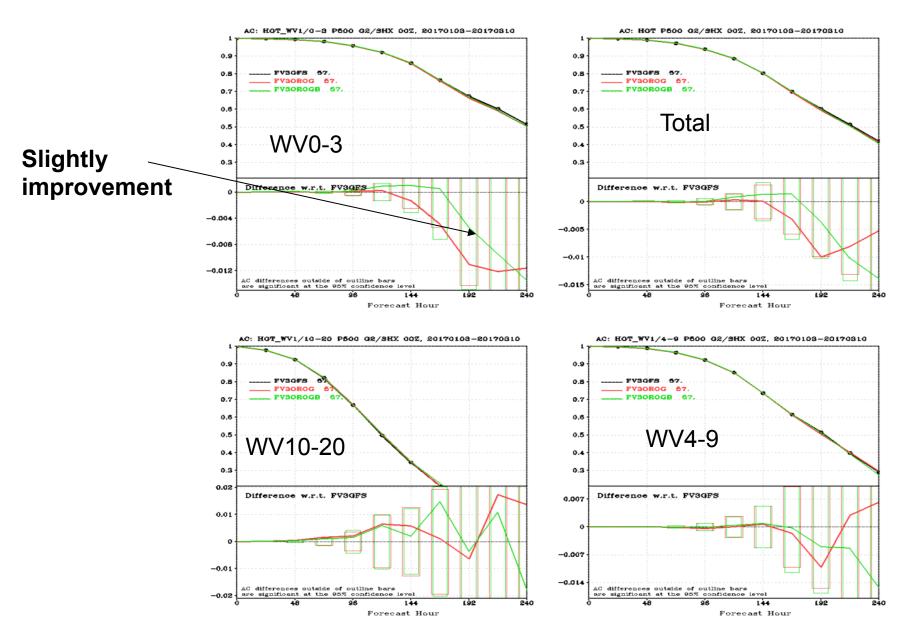








JF2017, SH 500-hPa HGT AC



Summary

 The impact of the new terrain data on fv3GFS forecast is not always positive, but overall the impact is small.

 GMTED2000 terrain datasets for different fv3GFS resolutions will be created. They will be used to replace the old GTOPO30 in the coming weeks.

 The model will be further tuned in combination with other model upgrades to obtain the best possible forecast skills.